TEXAS A&M UNIVERSITY

Lab Exercise

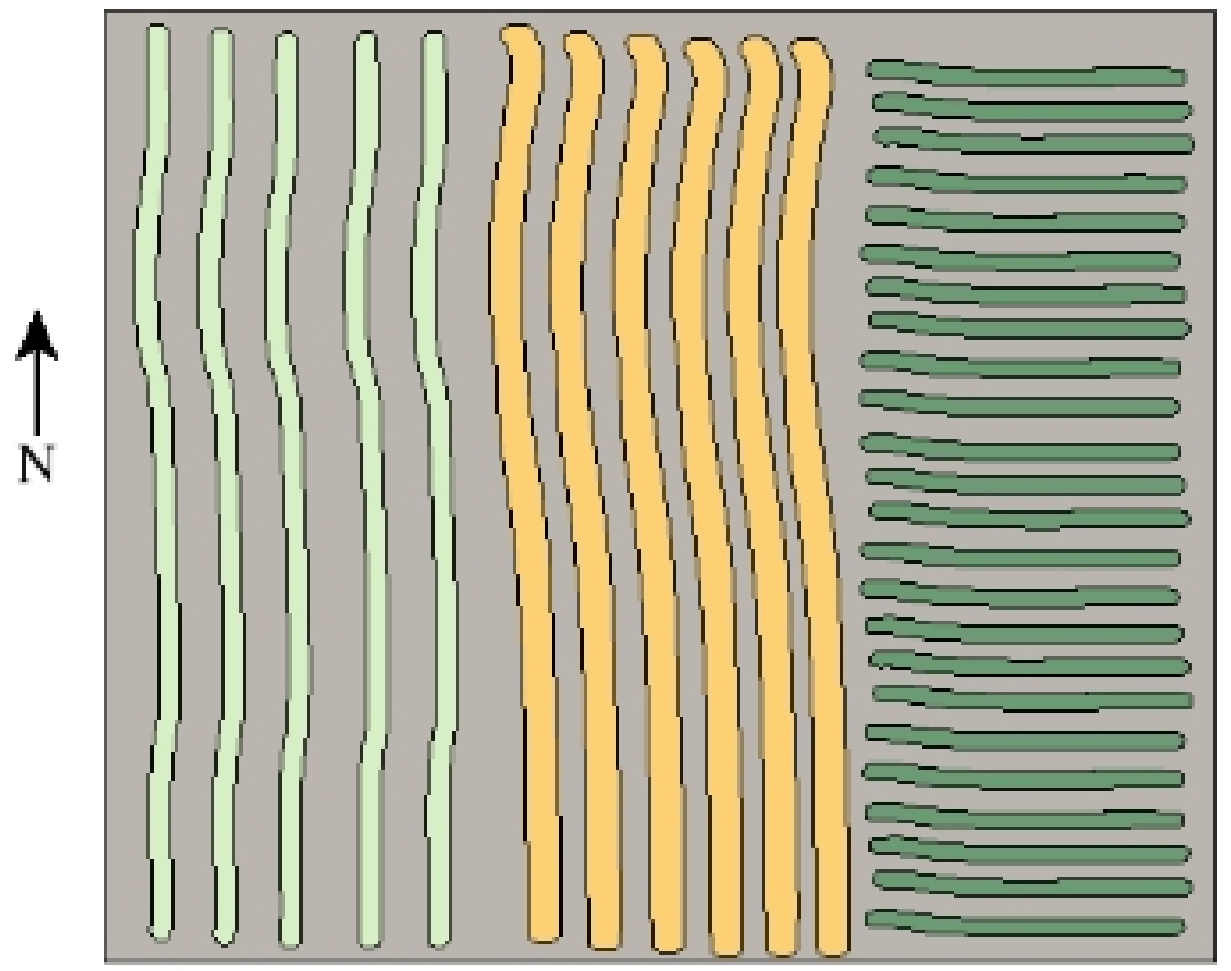
GEOG661
Laboratory Exercise 2

Digital Image Processing
Spatial Sampling and Quantization

Part 1 - Spatial Sampling

You have been asked to design a high tech sampling scheme investigate the health of the Iroquois "Three Sisters" which are corn, beans and squash in a flat field in the wilds of Texas. You will do the sampling using an Aircraft system and you have control of the flight plan (height, ground track etc.). In order to figure out how to accomplish this you need to do a little planning.

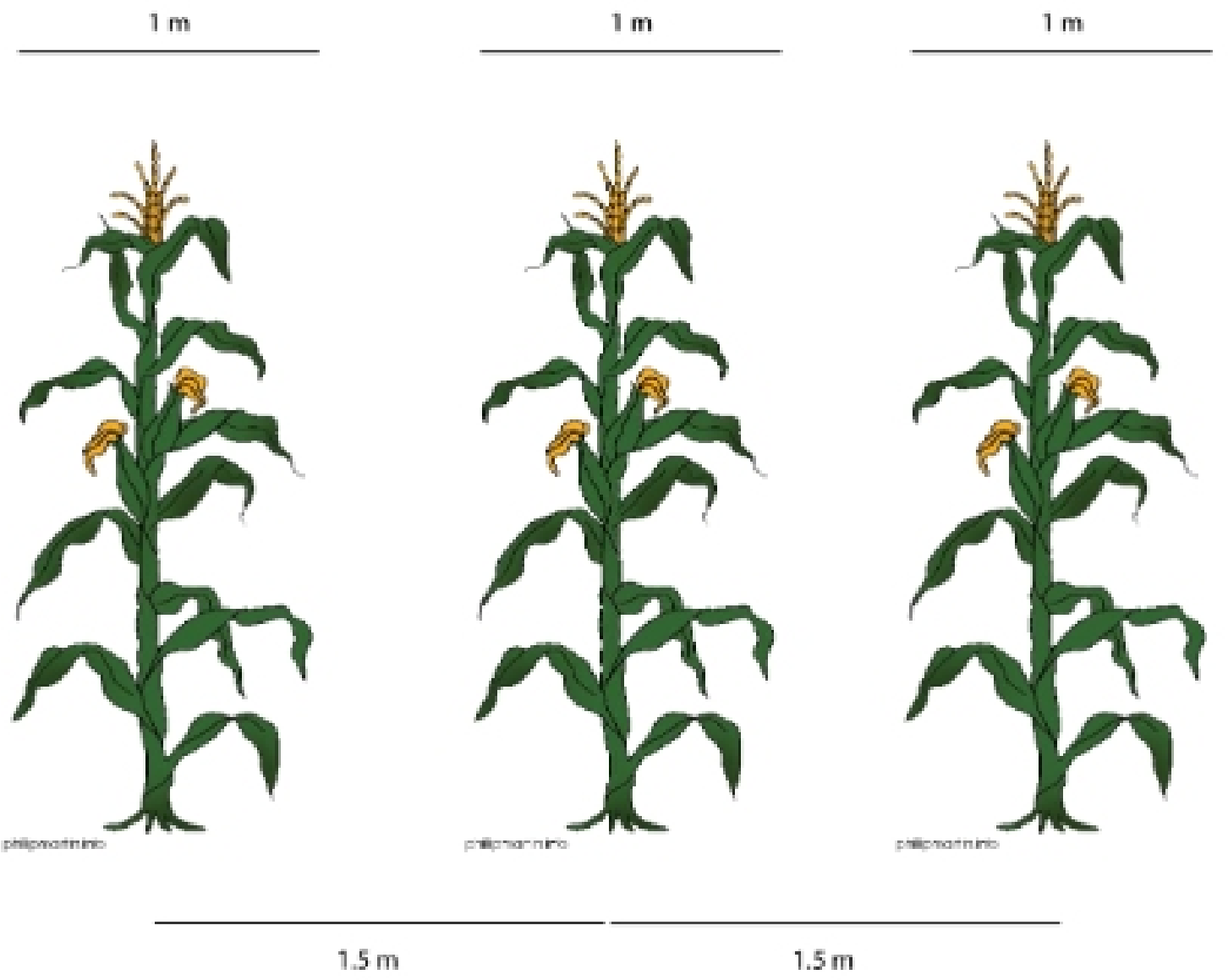
First, the field you are going to sample looks something like what is illustrated in the figure below. *Please note that this is a schematic diagram only and the rows represented in the figure do not represent the actual rows you might view if you looked down from an aircraft….*



The crops you are interested in imaging have the following attributes. You need to think carefully about how various properties these relate to the questions of spatial sampling and resolution we have discussed in class and are in the readings. It is important to select the correct measurement for the problem at hand. The figure following the table illustrates the parameters for corn.

	Corn	Squash	Beans
Row Width	1 meter	1.5 meter	0.5 meter
Row Spacing	1.5 meter	0.8 meter	0.5 meter
Row Orientation	North-South	North-South	East West

The figure below illustrates the following parameters for corn.



With this information please answer the following questions.

Question 1. Based on the attributes above, identify each crop in the picture.

Question 2. Assuming that you fly low enough so that your resolution cell is infinitesimally small, what is the critical sampling distance in the East-West Direction? In the North South Direction? *assume that you wish to fly perpendicular to the rows of crops of interest*

Question 3. If you wish to have a pure pixel of each of the three targets, what is the maximum size going to have to be in the East-West Direction, in the North-South direction? Is the resolution cell size smaller or larger than the sampling interval? Will this cause the loss of any pertinent information? Why or why not?

Question 4. Your aircraft system has an IFOV (β) of 5 milliradians and its resolution cell size is the same as the IFOV. You need to determine what altitude you have to fly at to achieve the pixel resolutions you determined in Question 4. You also know that the pixel resolution on the ground (p) is related to the aircraft height (h) by the approximation. $p = \beta h$.

Part 2 - Quantization

Now that you have proven your engineering prowess, you have been asked to mediate a dispute between oceanographers and biologists over the settings for a single band in the visible wavelengths for an instrument NASA is building. The root of the problem is that oceanographers want high quantization of the spectral information for a range of low reflectances, while the biologists are content with a larger quantization interval, but sensitivity over a wider range of refectances. You have been asked to achieve a compromise solution in terms of the range of radiances the instrument is able to detect and a suitable quantization interval. You have been told that at this point you do not have to worry about signal-to-noise problems (e.g. the quantization interval can be as small as you like), but the satellite-to-ground link will limit the data to a maximum of 10 bits of information per pixel from this band.

Here are the oceanographers ideal requirements. Sensitivity to reflectances ranging from 0.01 to 0.12. They are content with the specified range of radiance values being represented by 8 bits of information per pixel. However, any smaller of a radiance quantization interval is not acceptable.

Here are the biologists ideal requirements. Sensitivity to reflectances ranging from 0.1 to 0.8 with the specified 10 bits of information.

You should also remember that reflectance is defined as follows:

$$\text{reflectance} = \frac{\text{upwelling radiance}}{\text{downwelling irradiance}}$$

The spectral band is question runs from 0.526-0.536 μm. In this spectral interval the spectral radiance is 27.9 W m^{-2} μm^{-1} st^{-1}.

Question 1. What is the total radiance (W m^{-2} st^{-1}) in the bandpass?